CLAIMS

What is claimed:

[c01] A scintillator composition, comprising the following, and any reaction products thereof:

(a) a halide-lanthanide matrix material selected from the group consisting of

(i) a solid solution of at least two lanthanide halides; and

(ii) lanthanum iodide, substantially free of lanthanum oxyiodide;

and

(b) an activator for the matrix material, comprising an element selected from the group consisting of cerium, praseodymium, and mixtures of cerium and praseodymium.

[c02] The scintillator composition of claim 1, wherein the halide in the matrix material is selected from the group consisting of bromine, chlorine, and iodine.

[c03] The scintillator composition of claim 1, wherein the lanthanide in the matrix material is selected from the group consisting of lanthanum, yttrium, gadolinium, lutetium, scandium, and mixtures thereof.

[c04] The scintillator composition of claim 1, wherein the lanthanide in the matrix material is lanthanum.

[c05] The scintillator composition of claim 1, wherein the lanthanide halides of component (i) are selected from the group consisting of lanthanum

bromide, lanthanum chloride, lanthanum iodide, lutetium chloride, lutetium bromide, yttrium chloride, yttrium bromide, gadolinium chloride, gadolinium bromide, praseodymium chloride, praseodymium bromide, and mixtures thereof.

[c06] The scintillator composition of claim 1, wherein the solid solution comprises lanthanum chloride and lanthanum bromide.

[c07] The scintillator composition of claim 6, wherein the molar ratio of lanthanum chloride to lanthanum bromide is in the range of about 1 : 99 to about 99 : 1.

[c08] The scintillator composition of claim 7, wherein the molar ratio of lanthanum chloride to lanthanum bromide is in the range of about 10 : 90 to about 90 : 10.

[c09] The scintillator composition of claim 6, wherein the solid solution further comprises lanthanum iodide.

[c10] The scintillator composition of claim 9, wherein the amount of lanthanum iodide present is in the range of about 0.1 mole % to about 99 mole %, based on total moles of lanthanide halide present in the solid solution.

[c11] The scintillator composition of claim 10, wherein the amount of lanthanum iodide present is in the range of about 1 mole % to about 50 mole %.

[c12] The scintillator composition of claim 1, wherein the solid solution comprises lanthanum iodide and one of lanthanum chloride or lanthanum bromide.

[c13] The scintillator composition of claim 1, wherein the activator is present at a level in the range of about 0.1 mole % to about 20 mole %, based on total moles of activator and halide-lanthanide matrix material.

[c14] The scintillator composition of claim 13, wherein the activator is present at a level in the range of about 1 mole % to about 10 mole %.

[c15] The scintillator composition of claim 13, wherein the activator comprises cerium.

[c16] The scintillator composition of claim 1, in substantially monocrystalline form.

[c17] The scintillator composition of claim 1, in polycrystalline form.

[c18] The scintillator composition of claim 1, in the form of a polycrystalline ceramic material.

[c19] The scintillator composition of claim 1, in the form of a film.

[c20] A cerium-doped scintillator composition, comprising a mixture of at least two lanthanide halides.

[c21] The scintillator composition of claim 20, wherein the lanthanide halide mixture comprises lanthanum chloride and lanthanum bromide, in a molar ratio in the range of about 10 : 90 to about 90 : 10.

[c22] A cerium-doped scintillator composition, comprising lanthanum iodide, substantially free of lanthanum oxyiodide.

[c23] The scintillator composition of claim 22, wherein cerium is present at a level in the range of about 1 mole % to about 10 mole %, based on total moles of cerium and lanthanum iodide.

[c24] A radiation detector for detecting high-energy radiation, comprising:

(A) a crystal scintillator which comprises the following composition, and any reaction products thereof:

(a) a halide-lanthanide matrix material selected from the group consisting of

(i) a solid solution of at least two lanthanide halides; and

(ii) lanthanum iodide, substantially free of lanthanum oxyiodide; and

(b) an activator for the matrix material, comprising an element selected from the group consisting of cerium, praseodymium, and mixtures of cerium and praseodymium;

and

(B) a photodetector optically coupled to the scintillator, so as to be capable of producing an electrical signal in response to the emission of a light pulse produced by the scintillator.

[c25] The radiation detector of claim 24, wherein the lanthanide in the matrix material of the scintillator is lanthanum.

[c26] The radiation detector of claim 24, wherein the solid solution of the matrix material of the scintillator comprises lanthanum chloride and lanthanum bromide.

[c27] The radiation detector of claim 26, wherein the solid solution further comprises lanthanum iodide.

[c28] The radiation detector of claim 24, wherein the photodetector is at least one device selected from the group consisting of a photomultiplier tube, a photodiode, a CCD sensor, and an image intensifier.

[c29] The radiation detector of claim 24, operably connected to a well-logging tool.

[c30] The radiation detector of claim 24, operably connected to a nuclear medicine apparatus.

[c31] The radiation detector of claim 30, wherein the nuclear medicine apparatus comprises a positron emission tomography (PET) device.

[c32] The radiation detector of claim 24, operably connected to a digital imaging device.

[c33] The radiation detector of claim 24, operably connected to a screen scintillator.

[c34] A method for detecting high-energy radiation with a scintillation detector, comprising the steps of:

(A) receiving radiation by an activated, halide-lanthanide-based scintillator crystal, so as to produce photons which are characteristic of the radiation; and

(B) detecting the photons with a photon detector coupled to the scintillator crystal;

wherein the scintillator crystal is formed of a composition comprising the following, and any reaction products thereof:

(a) a halide-lanthanide matrix material selected from the group consisting of

(i) a solid solution of at least two lanthanide halides; and

(ii) lanthanum iodide, substantially free of lanthanum oxyiodide;

and

(b) an activator for the matrix material, comprising an element selected from the group consisting of cerium, praseodymium, and mixtures of cerium and praseodymium.

[c35] A method for producing an activated, halide-lanthanide-based scintillator crystal which comprises:

(a) a halide-lanthanide matrix material selected from the group consisting of

(i) a solid solution of at least two lanthanide halides; and

(ii) lanthanum iodide, substantially free of lanthanum oxyiodide;

and

(b) an activator for the matrix material, comprising an element selected from the group consisting of cerium, praseodymium, and mixtures of cerium and praseodymium,

said method comprising the following steps:

(i) supplying at least one lanthanide-containing reactant, at least one activator-containing reactant; and at least one halide-containing reactant; according to proportions which satisfy the stoichiometric requirements for the scintillator crystal;

(ii) melting the reactants at a temperature sufficient to form a molten composition; and

(iii) crystallizing a crystal from the molten composition.

[c36] The method of claim 35, wherein the lanthanide-containing reactant and the halide-containing reactant comprise a mixture of lanthanum chloride and lanthanum bromide; and the activator-containing reactant comprises cerium oxide, a cerium halide compound, or a mixture of cerium oxide and a cerium halide compound.

[c37] The method of claim 35, wherein the reactants are melted at a temperature in the range of about 650°C to about 1050°C.

[c38] The method of claim 35, wherein step (iii) is carried out by a technique selected from the group consisting of the Bridgman-Stockbarger method; the Czochralski method, the zone-melting method, the floating zone method, and the temperature gradient method.